

US Patent Application No. 10/657,505  
Reply to Office Action of April 3, 2006

## REMARKS

Claims 1-3, 5-15, 18-24, and 52-57 are currently pending. Claims 3, 4, 16, 17, 25-51 are canceled. Claims 1, 11, and 12 are amended. Claims 52-57 are added. Reconsideration of presently pending claims 1-3, 5-15, 18-24, and 52-57 is respectfully requested in light of the above amendments and the following remarks.

### **Claim Objections, Claim 6 and 22**

Applicants thank Examiner Geyer for the indication of allowable subject matter in claims 6 and 22. However, for the reasons set forth hereafter, Applicants respectfully submit that all of the claims are directed to allowable subject matter and that the application is in condition for allowance.

### **Rejections under 35 U.S.C. §102(b), Claims 1 and 10**

Claims 1 and 10 are rejected under 35 U.S.C. §102(b) as being allegedly anticipated by newly cited reference, Gates, et al. (US Patent No. 6,203,613 hereinafter referred to as “Gates”).

The PTO provides in MPEP § 2131 that

*“[t]o anticipate a claim, the reference must teach every element of the claim....”*

Therefore, with respect to claim 1, to sustain this rejection the Gates reference must contain all of the above claimed elements of the claim. However, contrary to the Examiner’s position that all elements are disclosed in the Gates reference, the reference does not disclose “flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, wherein the metal precursor comprises Ti{OCH(CH<sub>3</sub>)<sub>2</sub>}<sub>4</sub>, TDMAT, or TDEAT.”

At column 5, line 60 to column 6, line 6, Gates discloses that:

Specifically, the metal precursor compounds of the present invention comprise a metal nitrate-containing compound having the formula  $M(NO_3)_x$  wherein M is a metal selected from the group consisting of Ti, Ga, Sn, Co, V, Pt, Pd, Fe, Ni, Mo, W, Ag, Au, Hf, Cr, Cu, Mn, La, Y, Al, Gd, Nd, Sm, Si, Nb, Ta, and In; and x is the valency of M. In one embodiment of the present invention some, but not all of the  $NO_3$  ligands are replaced by a substituent R, wherein substituent R is selected from the group consisting of hydrogen, oxygen, oxynitrides such as  $N_2O_5$  or  $NO_2$ , hydroxyl, aromatic, alkyl, amine, silyl, alkoxide or  $\beta$ -diketone.

Thus, Gates' precursor is similar to the prior art precursor as described on page 9, lines 18-20 of the current specification, such as  $Ti(NO_3)_4$ , which can be explosive. Gates does not disclose a metal precursor that comprises  $Ti\{OCH(CH_3)_2\}_4$ , TDMAT, or TDEAT. Therefore, Gates does not disclose every limitation of claim 1.

By virtue of their dependency on claim 1, claim 10 is also not disclosed by Gates. Accordingly, Applicants respectfully request the withdrawal of the rejection to claims 1 and 10 under 35 U.S.C. §102(b).

#### **Rejections Under 35 U.S.C. §103(a), Claims 2, 5, 7, and 8**

Claims 2, 5, 7, and 8 are rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Gates. This rejection is respectfully traversed. As discussed above in arguments presented in claim 1, Gates does not disclose "flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, wherein the metal precursor is  $Ti\{OCH(CH_3)_2\}_4$ , TDMAT, or TDEAT." Since claims 2, 5, 7, and 8 depend from and further limit claim 1, Gates also does not disclose the features of claims 2, 5, 7, and 8. Accordingly, Applicants respectfully request the withdrawal of claims 2, 5, 7, and 8 under 35 U.S.C. §103(a).

#### **Rejections Under 35 U.S.C. §103(a), Claim 11**

Claim 11 is rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Gates in view of Cao et al. (U.S. Patent No. 6,972,267 herein referred to as "Cao"). Applicants traverse this rejection on the grounds that the reference is defective in establishing a *prima facie* case of obviousness with respect to claim 11.

As the PTO recognizes in MPEP § 2142:

*... The examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of nonobviousness...*

It is submitted that, in the present case, the Examiner has not factually supported a prima facie case of obviousness for the following, mutually exclusive, reasons.

#### **1. Even When Combined, the References Do Not Teach the Claimed Subject Matter**

The Gates and Cao references cannot be applied to reject claim 11 under 35 U.S.C. §103(a), which provides that:

*A patent may not be obtained ... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains ... (Emphasis added)*

Thus, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. As discussed above in arguments presented for claim 1, Gate fails to disclose “wherein the metal precursor comprises Ti{OCH(CH<sub>3</sub>)<sub>2</sub>}<sub>4</sub>, TDMAT, or TDEAT.” While the Examiner admits that Gates does not disclose the specific metal precursors as recited in claim 11, the Examiner alleges that Cao discloses such features in the abstract. However, Cao merely discloses “a liquid precursor (‘BuN)Ta(NEt<sub>2</sub>) (TBTDET) to form a tantalum-containing gas that includes TBTDET.” (Column 3, lines 65-67). Cao does not mention any precursor that comprises Ti{OCH(CH<sub>3</sub>)<sub>2</sub>}<sub>4</sub>, TDMAT, or TDEAT. This is because Cao is only interested in “barrier layers formed from sputtered tantalum (Ta) and reactive sputtered tantalum nitride (Ta<sub>N</sub>).” Cao fails to mention anything about precursor that includes Ti. Therefore, Cao also does not disclose these features in claim 11.

The Examiner alleges that it would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method of Gates with TBTDET as metal precursor as taught by Cao since TBTDET has a lower deposition temperature compared to metal-hallide precursors. Applicants respectfully disagree. Neither Gates nor Cao discloses or suggests precursor that comprises  $\text{Ti}\{\text{OCH}(\text{CH}_3)_2\}_4$ , TDMAT, or TDEAT. One of ordinary skill in the art would not have been led to modify Gates' prior art precursor and Cao's TBTDET precursor to reach a metal precursor that comprises  $\text{Ti}\{\text{OCH}(\text{CH}_3)_2\}_4$ , TDMAT, or TDEAT.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claim 11 under 35 U.S.C. §103(a) should be withdrawn.

## 2. The Combination of References is Improper

Assuming, arguendo, that none of the above arguments for non-obviousness apply, there is still another, mutually exclusive, and compelling reason why Gates and Cao cannot be applied to reject claim 11 under 35 U.S.C. § 103(a).

§ 2142 of the MPEP also provides:

*...the examiner must step backward in time and into the shoes worn by the hypothetical 'person of ordinary skill in the art' when the invention was unknown and just before it was made.....The examiner must put aside knowledge of the applicant's disclosure, refrain from using hindsight, and consider the subject matter claimed 'as a whole'.*

Here, neither Gates nor Cao discloses, or even suggests, the desirability of the combination of "a metal precursor of  $\text{Ti}\{\text{OCH}(\text{CH}_3)_2\}_4$ , TDMAT, or TDEAT." Gates merely discloses prior art precursor such as  $\text{Ti}(\text{NO}_3)_4$ . Cao merely discloses a liquid precursor TBTDET. Neither Gates nor Cao discloses or suggests  $\text{Ti}\{\text{OCH}(\text{CH}_3)_2\}_4$ , TDMAT, or TDEAT. Therefore, one of ordinary skill in the art would not have been led to combine or modify the disclosure of Gates and Cao to reach the features of claim 11. Even if one of ordinary skill in the art were to modify or combine the disclosures, the resulting combination still would not include a precursor that comprises  $\text{Ti}\{\text{OCH}(\text{CH}_3)_2\}_4$ , TDMAT, or TDEAT, since neither reference discloses such precursors.

Thus, it is clear that neither reference provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. § 103 rejection.

In this context, the MPEP further provides at § 2143.01:

*The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.*

In the above context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

In the present case it is clear that the Examiner's combination arises solely from hindsight based on the invention without any showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 11. Therefore, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claim 11 under 35 U.S.C. §103(a) should be withdrawn.

#### **Rejections Under 35 U.S.C. §103(a), Claims 12-15, 18, 20, 21, and 23**

Claims 12-15, 18, 20, 21, and 23 are rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Gates in view of Cao and further in view of Choi et al (U.S. Patent No. 6,815,285). Applicants traverse this rejection on the grounds that the reference is defective in establishing a *prima facie* case of obviousness with respect to claim 12.

#### **1. Even When Combined, the References Do Not Teach the Claimed Subject Matter**

The Gates, Cao, and Choi references cannot be applied to reject claim 12 under 35 U.S.C. §103(a). As discussed above in arguments presented for claims 1 and 11, neither Gates nor Cao discloses or suggests "wherein the metal precursor comprises Ti{OCH(CH<sub>3</sub>)<sub>2</sub>}<sub>4</sub>, TDMAT, or TDEAT." Choi also does not disclose such features. At column 5, lines 30-39, Choi discloses:

When the initial metal nitride layer 107 is formed using the CVD or ALD technique, it may be formed by a tantalum precursor that is selected from at least one of the group consisting of tantalum fluoride ( $TaF_5$ ), tantalum iodide ( $TaI_5$ ), tantalum bromide ( $TaBr_5$ ), tantalum chlorine ( $TaCl_x$ ),  $Ta(NEt_2)_5$ ,  $Ta(NMe_2)_5$ , and t-butylimido-tris(diethylamido) tantalum (TBTDET).

Thus, similar to Coa, Choi merely discloses tantalum-containing precursors. Choi does not mention anything about  $Ti\{OCH(CH_3)_2\}_4$ , TDMAT, or TDEAT. Therefore, Choi also fails to disclose the features of claim 12.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claims 12-15, 18, 20, 21, and 23 under 35 U.S.C. §103(a) should be withdrawn.

## 2. The Combination of References is Improper

Assuming, arguendo, that none of the above arguments for non-obviousness apply, there is still another, mutually exclusive, and compelling reason why Gates, Cao, and Choi cannot be applied to reject claims 12-15, 18, 20, 21, and 23 under 35 U.S.C. § 103(a). Here, Gates, Cao, and Choi fail to disclose, or even suggest, the desirability of the combination of "a metal precursor that comprises  $Ti\{OCH(CH_3)_2\}_4$ , TDMAT, or TDEAT," as recited in claim 12. Gates merely discloses prior art precursor such as  $Ti(NO_3)_4$ . Cao merely discloses a liquid precursor TBTDET. Choi also only discloses tantalum-containing precursors. None of the references discloses or suggests  $Ti\{OCH(CH_3)_2\}_4$ , TDMAT, or TDEAT. Therefore, one of ordinary skill in the art would not have been led to combine or modify the disclosure of Gates, Cao, and Choi to reach the features of claim 12. Even if one of ordinary skill in the art were to modify or combine the disclosures, the resulting combination still would not include a precursor that comprises  $Ti\{OCH(CH_3)_2\}_4$ , TDMAT, or TDEAT, since none of the references discloses such precursors.

Thus, it is clear that none of the references provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. § 103 rejection. In the present case it is clear that the Examiner's combination arises solely from hindsight based on the invention without any showing, suggestion, incentive or motivation in either reference for the combination as applied to claim 12. Therefore, for this mutually exclusive reason,

the Examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claims 12-15, 18, 20, 21, and 23 under 35 U.S.C. §103(a) should be withdrawn.

**Newly added claims, Claims 52-57**

Claim 52 is added to recite "a method for forming an interconnect: providing a substrate; forming a conductive layer within the substrate; depositing a dielectric layer on the substrate; forming an opening within the dielectric layer; depositing a composite layer on the substrate in a chamber by flowing a metal precursor that comprises Ti{OCH(CH<sub>3</sub>)<sub>2</sub>}<sub>4</sub>, TDMAT, or TDEAT into the chamber; and planarizing the composite layer to be coplanar with the dielectric layer." These features are supported at least on page 8, line 8 to page 10, line 15 of the current specification.

Claim 53 is added to recite "wherein the composite layer comprises a plurality of metal nitride monolayers." These features are supported at least on page 10, lines 2-4 of the current specification. Claim 54 is added to recite "wherein each of the plurality of metal nitride monolayers comprises at least one metal and nitrogen." These features are supported at least on page 10, lines 2-4 of the current specification.

Claim 55 is added to recite "wherein the at least one metal is titanium." These features are supported at least on page 10, lines 19-20 of the current specification. Claim 56 is added to recite "wherein depositing a composite layer on the substrate further comprises: purging an inert gas into the chamber to remove metal precursor not bonded to the substrate; flowing a nitrogen-containing reactant into the chamber to form one of the plurality of metal nitride monolayer; and purging an inert gas into the chamber to remove nitrogen-containing reactant not reacted with the metal precursor." These features are supported at least on page 10, line 15 to page 12, line 16 of the current specification. Claim 57 is added to recite "wherein the first flowing step, the first purging step, the second flowing step, and the second purging step are performed repeatedly until a desire thickness of the composite layer is deposited." These features are supported at least on page 12, lines 7-9 of the current specification. Applicants respectfully submit that none of the references discloses or suggests the features of claims 52-57, since Gates, Cao, and Choi all fail to disclose a metal precursor that comprises Ti{OCH(CH<sub>3</sub>)<sub>2</sub>}<sub>4</sub>, TDMAT, or TDEAT.

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**Conclusion**

It is clear from all of the foregoing that independent claims 1, 11, 12, and 52 are in condition for allowance. Dependent claims 2-3, 5-10, 13-15, 18-24, and 53-57 depend from and further limit independent claims 1, 11, 12, and 52 and therefore are allowable as well.

An early formal notice of allowance of claims 1-3, 5-15, 18-24, and 52-57 is requested.

Respectfully submitted,



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